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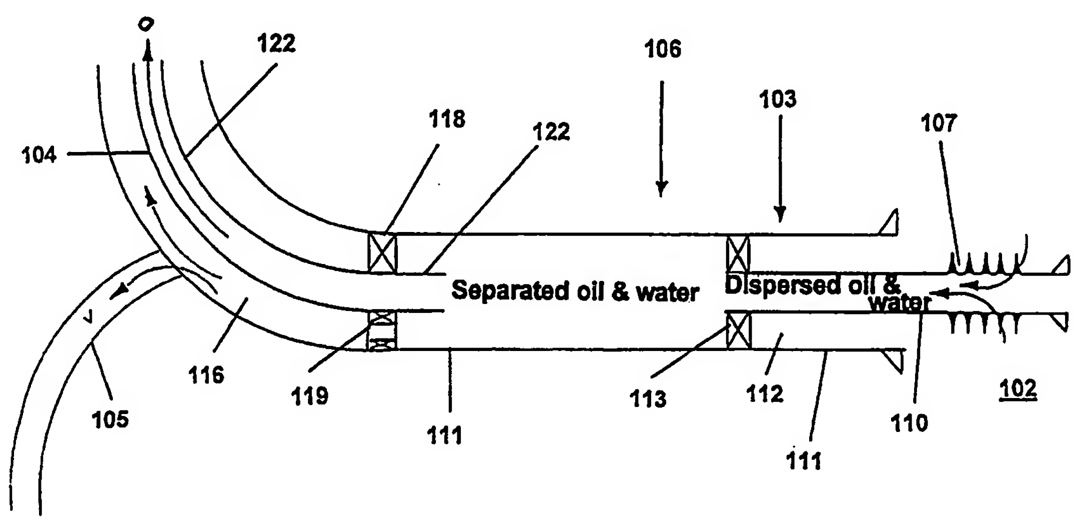

(57) Abstract

Method and device for separation of a fluid comprising several fluid components, especially separation of a well fluid in connection with a pipe for production of hydrocarbons/water. The fluid is fed into one end of a mainly horizontal pipe of a length adapted to the current conditions of flow, with the fluid flowing through the pipe at such a speed that it is separated. During separation fluid components with a low density are formed in the top part of the pipe and fluid components with a higher density are formed in the lower part of the pipe. The fluid components are taken out through separate outlets.

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A method and device for the separation of a fluid in a well

The present invention relates to a method and device for separation of a fluid comprising several fluid components, especially separation of a well fluid in connection with a pipe for production of hydrocarbons/water.

It has previously be proposed that well fluids in vertical wells should be handled using separators. Such separators can comprise semi-permeable filters which are only pervious to water as described in US 4,241,787 or cyclones as described in NO 172426.

A disadvantage with these devices is that they are relatively complicated in their construction and/or have many moving parts. Moreover, the aforementioned solutions would require extensive maintenance/inspection when used in wells having high pressure and high temperature. Another factor is that these solutions are specially adapted for installation in vertical sections of wells. They would also represent extra pressure loss and consume energy.

The above disadvantages can be avoided with the present invention. The invention has been specially developed to be able to separate fluids in horizontal sections of wells, something which is very advantageous in the recovery of horizontal formations where the well is formed by means of horizontal drilling for example.

Other advantages to be achieved when using the invention in connection with long (horizontal) wells in particular are:

- less pressure loss owing to reduced transport of water together with hydrocarbons
- simpler (and smaller) downstream equipment for separation
- the amount of water with chemicals released at sea can be greatly reduced
- no salt deposition in production equipment downstream of the well
- minimisation of hydrates problem

- minimisation of corrosion problems in transport pipes and process equipment
  (can lead to choice of cheaper materials
- separation of oil/water in the well can lead to simplifications owing to large drops, lack of stabilising surfactants, high temperature and low viscosity
- good capacity in relation to energy consumption and investments

In the following the invention will be described further by means of examples and figures in which:

Figure 1 shows an oil/water flow pattern diagram

Figure 2 shows separation in a well separator as a function of separator length, (%) content of water in the product oil

Figure 3 shows separation in a well separator as a function of separator length, (ppm) content of oil in the product water

Figure 4 shows a well with production equipment and a separator

Figure 5 shows an embodiment of a separator

Figure 6 shows a second embodiment of a separator

Figure 7 shows a flow diagram for a separator of the type shown in figure 6

Figure 8 a),b),c) shows a third embodiment of a separator with different flow patterns.

Figure 9 shows a fourth embodiment of a separator.

Figure 1 is a diagram which shows the flow in a fluid comprising an oil component and a water component in relation to the speed of the individual component. As the figure shows it has been established by means of experiments that it is possible to achieve a stratified flow if the speed of flow of the components is of an order of magnitude of less than 0.6 metres per second.

Figure 2 is a diagram which shows the results arrived at in experiments carried out in a test rig using a light crude oil quality from a field in the North Sea. The fluid

essentially consisted of the fluid components oil and water. A dispersed flow with a speed of V_{mix} 0.6 m/s was initiated in the rig. The tests were carried out to find out what criteria have to be satisfied to achieve the desired degree of separation. Other parameters were as follows:

System pressure 105 bar
System temperature 70°C
Oil viscosity: 1.02 mPa*S
Oil density: 736 kg/m³

A separator consisting of a horizontal pipe with an inside diameter of D = 0.78 m was installed in the rig.

The x-axis in the diagram is represented by a parameter as follows:

$$60.3 * (D^3 / Q) * L$$

where: D = inside diameter of the separator pipe (metres)
Q = total volume flow of the well fluid (cubic metres/hour)
L = length of separator pipe

The above parameters include the total retention time for the fluid and a correction factor for varying head (sedimentation distance) at a constant retention time for the fluid, depending on different values for the inside diameter of the pipe.

The y-axis of the diagram indicates the percentage quantity of water in the oil phase.

The diagram in figure 3 was produced by means of the experiment described above. The y-axis of this diagram indicates the quantity of oil in the water phase in parts per million (ppm), while the x-axis is the same as in figure 2.

It should be noted that the results set out in the diagrams in figures 2 and 3 are based on experiments carried out using a specific well fluid and basically only apply to that fluid. Other well fluids would have similar separation properties, however, which could therefore be determined by means of similar experiments. As well fluids can have different emulsion stability properties, they would require a shorter or longer retention time in the separator until equivalent separation was achieved.

Based on the above experiments it is now possible to separate a well fluid in horizontal wells or wells with horizontal sections of sufficient length. When a well fluid flows from a reservoir and in through perforations in a pipe in a well, the well fluid will assume a dispersed flow. Downstream in the production pipe, particularly in sections which are essentially horizontal, the fluid components can assume a stratified flow if the speed of flow of the well fluid is low enough and the retention time is long enough. In the following practical solutions will be described for separation of such a flow based on the above knowledge.

Figure 4 shows the principal elements in a supplementary solution for recovery of a formation 2. A pipe is placed in a horizontal section of a well in the formation 2. The pipe 1 comprises a horizontal transport pipe or separation 3 in which there is a separator 6. Upstream of the separator the pipe 1 is attached to drainage elements or perforations 7 which permit well fluid to flow in. Downstream of the separator the pipe 1 comprises a vertical riser 4. The pipe 1 can also be attached to a water injection pipe 5 with injection apertures 8 for injection of separated water into the formation.

Figure 5 shows an enlarged/detailed section of a supplementary solution as illustrated in figure 4. At its upstream end the horizontal transport pipe 3 is attached to an extension pipe 10 with perforations 7 for drainage of the formation 2. Well fluid is fed into the extension pipe 10 and flows in the direction of the

separator. The extension pipe can be surrounded by a casing 11 in such a way that an annulus 12 is formed between these pipes. The annulus is closed off towards the separator 6 by means of a packing 13 and if necessary cement. If necessary the extension pipe 10 can be replaced with any type of supplementary solution over one or more reservoir sections.

The separator as illustrated in this example is a pipe-shaped body or section of pipe 14 which has one or more drainage apertures 15 at its downstream end to allow water to drain out of the separator 6. The drainage apertures are chiefly positioned in the bottom part of the section of pipe 14. The pipe-shaped body can with advantage be surrounded by the casing 11 so that water which drains out of the section of pipe 14 through the aperture(s) 15 will be collected in an annulus (16) formed between the section of pipe 14 and the casing 11. If necessary the drainage apertures 15 can be adjustable by means of one or more movable sleeves (17) which can cover/uncover the apertures. The sleeves can be positioned inside the pipe 15 or surround it as shown in the figure. The section of pipe 14 can with advantage be an extension of a production pipe 22.

The annulus can be closed off with a packing 26 in the downstream direction and connected to a water injection pipe 5 for returning water to the formation 2. If necessary the injection pipe can be connected to equipment such as a valve 30, pumps etc. (not shown) so as to achieve a controlled return of water to the reservoir. If desirable the water injection pipe can be connected via a pipe 34 to equipment 31 such as a cyclone for further separation of the water flow. The separated water can then be fed back to the reservoir via a pipe 32 with injection apertures 35, while oil containing water is fed back to the production pipe 22 via pipe 33.

Alternatively the packing 36 can comprise a valve 27 which can be opened and which permits water to be fed to the surface via the annulus 16 between the production pipe and the casing. If necessary just a small flow of water can be fed

up to the surface in this way, or by using a separate pipe (not shown), for sampling and measuring the oil content of the water.

At its downstream end the separator 6 comprises a blocking device 18 which closes off the cross-section of the section of pipe 14 with the exception of one or more apertures 19 in the top of the blocking device. The aperture(s) 19 permit(s) oil to flow from the separator to the production pipe 22. Upstream of the blocking device there is a gamma densiometer 20 which comprises sensors connected to a signal-processing unit (not shown) which makes it possible to establish the level of the boundary layer (level in vertical direction) between the fluid components. This type of multilevel gamma radiation can be used to both detect the level and measure the concentration profile. Moreover, the phase boundary can be established and the oil in the water and water in the oil determined. This type of registration system represents technology of which the specialist is master and will therefore not be described in detail here.

Depending on the purity of the water to be separated out from the well fluid, the boundary layer 25 is regulated high enough in the pipe 14 for a small percentage of water to be fed into the production pipe 22 together with the oil if necessary. Regulation of the boundary layer, including achievement of a constant boundary layer at the desired place in the separator, can be carried out by controlling the outflows from the separator. This can for example be achieved by means of a valve 28 in the production pipe or at the wellhead (not shown) which controls the amount of fluid taken out through the production pipe 22 and regulation of the amount of drained water using the sleeve(s) 17 and/or valve 30 in the water injection pipe 5. The level of the boundary layer can therefore be raised or lowered in the section of pipe 14 by means of reciprocal regulation of the quantity of separated fluids. It should be understood that this regulation can be carried out using a data-processing unit (not shown) which processes the signals registered by the gamma densiometer, processes them in accordance with a set procedure or software and passes signals to admission devices (not shown) which are

connected to the aforementioned valves for regulation of the separated fluids. This represents technology of which the specialist is master and will therefore neither not be described in detail here.

Another system for regulating the vertical level of the interface 25 between the fluid components is to measure the quantity of water in the oil (WiO) and the oil flow (Q oil). These quantities are measured downstream of the separator and can with advantage take the form of continuous measurements. The measuring equipment can either be located down in the well, on a platform or on the surface.
Using this information the water in the oil can be plotted as a function of oil flow. As long as the oil/water boundary layer in the separator is lower that the oil outlet, the gradient of water in the oil in relation to the oil flow will be low. If the boundary layer approaches the oil outlet, the water in the oil will rise sharply as the oil flow increases. This information can easily be used to control the oil flow in such a way that the separator just barely allows water into the oil outlet.

Alternatively the oil in the water (OiW) can be registered and used to control the level of the boundary layer. This registration can be done at the surface by a small sub-flow of the water which is separated in the separator being taken up to the surface for analysis/measurement of the oil content.

If the speed of the well fluid is too high before it enters the separator, with the result that the conditions for separation cannot be achieved, the speed can be reduced in several ways. The speed of the well fluid upstream of the separator can for example be reduced by decreasing the amount of the fluids extracted at the wellhead and injection pipe.

Alternatively the speed of the well fluid can be regulated by limiting the inflow through the drainage elements or perforations. This can for example be done by closing off the perforations completely or partly using one or more movable sleeves (23). Another method can be to install one or more restrictions in the extension

pipe 10 or in another suitable place upstream of the separator. The restriction(s) will help to limit the speed of the well fluid before it reaches the separator. Such restrictions can be bodies which are inserted in the pipe and exhibit a reduction in flow area. Disc-shaped restrictions (plug with passage for fluid) can be used for example.

Figure 6 relates to another embodiment of a separator 106 and shows a detailed cross-section through a separator in a supplementary system as shown in figure 4. As in the previous example the horizontal transport pipe 103 is connected at its upstream end to an extension pipe 110 with perforations 107 for draining the formation 102. Well fluid is fed into the extension pipe 110 and flows in the direction of the separator 106. The extension pipe is surrounded by a casing 111 in such a way that an annulus 112 is formed between these pipes. The annulus is closed off towards the separator 106 by means of a packing 113 and if necessary cement. In this embodiment the extension pipe is closed off at the inlet end of the separator. The extension pipe 110 can if necessary be replaced with any type of supplementary solution over one or more reservoir sections.

The separator as shown in this example is a pipe-shaped body or section of pipe which represents an expansion in relation to the flow area in the extension pipe 110. The section of pipe can with advantage be the casing 111. If the diameter of the separator is expanded as shown in this embodiment, the length of the separator can be reduced.

At the outlet end of the separator there is a production pipe 122 which is surrounded by the casing 111. The annulus 116 formed between these pipes is sealed with a packing 118 which has one or more apertures 119 in its bottom part to allow water from the separator to flow through. The water can follow the annulus between the production pipe 122 and the casing 111 either to the surface or to a water injection pipe 105. Oil is fed out of the separator by means of the production

pipe 122. The production pipe can project into the inside of the separator with advantage.

It should be understood that the arrangement described under figure 5 for regulation of the boundary layer between the fluid components and regulation of the speed of the well fluid can of course also be implemented in this solution. The same applies to what was described regarding the systems for injection and further separation of the water component.

Figure 7 shows a flow diagram for a separator 106 of the type illustrated in figure 6, in which the dispersed oil/water flows into the separator from an extension pipe 110. This example uses a 7" extension pipe and a 10¾" casing 111 as the outer pipe of the separator. The height of the annulus is specified by the length H (distance between extension pipe and casing).

In this example there is at the distance 8H a coalescence-promoting insert or screen 140 which is a pierced disk with a cut in its bottom part. When the disc is inserted in the separator the aforementioned cut will form an aperture 141 which will permit the heaviest fluid components to flow through. The separator can comprise additional screens 142, 143 inserted downstream of the first screen. Such inserts or screens can be used to promote separation in such a way that the speed of the fluid to be separated can be increased in relation to what has been stated above. As the diagram shows, drops (oil) will coalesce and float up in the top part of the separator. With a speed of 0.9 m/s in the separated flow and a separator length of 26 m the flow will be layered towards the separator outlet (production pipe inlet) in such a way that the oil flows into the production pipe 122 and the water enters the annulus 116. The other parameters for the flow illustrated in the diagram are viscosity 2 cp, oil density 880 kg/m³, rate 4000 Sm³/d, water cut 30%.

Figure 8a) relates to a third embodiment of a separator 206 and shows a detailed cross-section through a separator in a supplementary system as described in figure 4.
This embodiment has a number of structural similarities with the preceding examples, but has a diameter which may be larger than that permitted by the diameter of the casing.

The horizontal transport pipe 203 comprises an extension pipe 210 and a casing 211. Between these two pipes there is an annulus 212 which can if necessary be separated from the reservoir using a packing 226. On the upstream side of the separator there is a plug 213 which closes off the extension pipe 210. If necessary a packing 225 can be fitted in the annulus 212 in such a way that it covers the entire area of the annulus with the exception of one or more apertures 214 in the bottom part of the annulus for example. Upstream of the plug 213 the extension pipe has one or more apertures 215 in its bottom part for example which permit well fluid being transported in the extension pipe 210 to flow out into the annulus 212. The fluid passes through the apertures 214 in the packing 225 and the flows into the separator 206.

The separator as illustrated here is a radial expansion of the outside dimension of the transport pipe 203, but as in the previous example the outside dimension can if necessary be the same as the outside dimension of the casing. The separator comprises an annulus 216 formed between a perforated pipe 218 and a section of pipe 217 which can be an expanded well hole supported by or closed off by means of an expandable pipe, a material hardened in situ or a consolidated formation (not shown in detail). Such pipes can be installed in accordance with inherently known techniques. The perforated pipe 218 can be supported at its upstream end by the extension pipe 210. At its downstream end the perforated pipe is connected to a production pipe 222. Alternatively the extension pipe, perforated pipe ad production pipe can be a continuous pipe with the specified apertures 215, 221 and plug 213.

The annulus of the separator 216 is equipped to communicate with the annulus 212 at its upstream end and with an annulus 223 formed between the production pipe 222 and the casing 211 at its downstream end.

Well fluid which flows into the annulus 216 will be separated in that fluid components with the lowest density (oil and possibly gas) will push up into the top part of the annulus. Here the perforated pipe 218 is equipped with outlets or apertures 221 which allow the fluid components to advance into the pipe and flow on downstream of the production pipe 222. Fluid components with a higher density such as water will be collected in the bottom part of the annulus. The annulus communicates downstream with annulus 223 and the heavier fluid components will therefore be carried away from the separator in this annulus.

A packing 219 is fitted in the annulus 223 downstream of the separator. The packing covers the entire area of the annulus with the exception of one or more apertures 224 in the bottom of the packing. The apertures allow the heavier, separated fluid components to flow through.

It should be understood that the arrangement described under figure 5 for regulation of the boundary layer between the fluid components and regulation of the speed of the well fluid can of course also be implemented in this solution. The same applies to what was described regarding the systems for injection and further separation of the water component.

The apertures 221 in the perforated pipe 218 can with advantage be designed with the regulation system which is to regulate the level of the boundary layer in mind, so that control of the outflows from the separator are as even as possible. This can be achieved by the apertures being slit-shaped in the vertical direction or triangular with one corner pointing down (not shown) so that an increase in the

level of the boundary layer 227 will produce a limited/progressive increase of water in the oil which is taken out through the apertures 221.

Figure 8b) shows the same solution as is shown in Figure 8a), but with another flow pattern where apertures 221 are provided on the lower side or the pipe 218 such that the heaviest fluid components, i.e. the water flows into the pipe and further up through the production pipe 222, while the lighter components flows up through the annulus 223.

Figure 8c) shows a further flow pattern, where the pipe 218 is provided with apertures on the upper as well as the lower side of the pipe, and whereby the lighter fluid components will flow into the pipe and into upper side, while the heavier components will enter into the pipe 218 at its lower side. For inside the pipe 218 is provided two separate pipes or channels 228,229 for further separate transport of the two respective fluid components.

Figure 9 shows a fourth embodiment of a separator according to the invention - moreover, Figure 9a) shows a part of a well system 301 with drainage pipe and branch pipes 302 and a separator 305 with a water injection well 304, Figure 9b) shows in enlarged scale part of the well shown in Figure 9a), and Figure 9c) shows a section along line A-A in Figure 9b).

As is shown in the figure, the separator includes a transport pipe 303 with a joint injection well pipe 304. Oil and/or gas mixed with water flows via inflow restriction devices 316 from the drainage pipe and branch pipes 302 to the transport pipe 303 in the separator 305. Here the water and oil is separated with an upper 308 and lower 307 layer respectively. Preferably, a threshold 315 may be provided in the area where the transport pipe 303 and injection pipe 304 interconnect. Such threshold will secure water being present at a certain level.

The water flows further to the water injection pipe 304, while the oil flows upwards to the production pipe 306. The water flowing into the water injection pipe 304, will contain oil which will be separated in the upper part of the pipe (oil-/water interface at 309). A level control 310 (not further shown) detects the oil level and controls a pump 311 which injects the water down into the injection pipe 304. The level control may a capacity type or a combination of capacity and conductivity type control.

It should be emphasized that the drawings are just giving an indication of the different dimensions and distances being used in connection with any practical solution of the invention. Thus, for instance the distance between the transport pipe 303 and the control 310, and the distance between the transport pipe and the pump may be of 50 to 100 metres or more.

The pump 311 as shown in the figure is preferably provided at the end of a completion string 312, close below a packing 313 which separate the separator 305 from the lower part of the injection well pipe. The completion string contains (not shown) electric or hydraulic lines for the supply of energy to the pump.

Besides, the completion string is provided with apertures 314 on the upper side of the packing 313 so that the water being injected to the injection well may flow through these apertures, further through the string 312 and to the pump 311.

The invention is not limited to the above examples. Thus, it may also be relevant to use coalescence-promoting chemicals in connection with the separator. This may be relevant where surfactants are present (e.g. asphalt particles which cannot be held in solution by resins) and prevents drops joining. The effect of the surfactants can be counteracted by oil-soluble emulsion breakers/antifoam agents and asphalt dispersants. If necessary these can be injected continuously upstream of the separator.

It is also possible to connect additional valves to the inlet and outlets of the separator to regulate the inflow of well fluid and the outflow of the fluid components. The separator can also comprise other available equipment for monitoring/checking that its operating conditions are being met. It can for example comprise equipment for measuring the volume flow/speed/pressure/temperature of the fluid/fluid components.

Claims

1. Method for separation of a fluid comprising several fluid components, especially separation of a well fluid in connection with a pipe for production of hydrocarbons/water,

   characterised in

   that the fluid is fed into one end of a mainly horizontal section of pipe or bore in which the fluid is set to flow at such a speed that the fluid is separated and a boundary layer is formed between the fluid components, whereby fluid components with a low density are formed in the top part of the section of pipe and fluid components with a higher density are formed in the bottom part of the section of pipe, and that the fluid components are taken out through separate outlets.

2. Method according to claim 1,

   characterised in

   that the speed of the fluid to be separated is regulated by means of restrictions or the like placed upstream of the section of pipe.

3. Method according to claim 1,

   characterised in

   that the speed of the fluid to be separated is regulated by means of flow regulation of the separated fluid components.

4. Method according to claim 1,

   characterised in

   that the level of the boundary layer is detected by means of measuring equipment and set by means of reciprocal flow regulation of the separated fluid components which are taken out of the section of pipe.

5. Method according to claim 1,

c h a r a c t e r i s e d i n

that the fluid components with the highest density are injected back into the formation, if necessary after passing through a further separation stage, with the fluid components with a lower density being brought up to the surface of the formation.

6. Device for separation of a fluid comprising several fluid components, especially separation of a well fluid in connection with a pipe for recovering hydrocarbons/water,

c h a r a c t e r i s e d i n

that it comprises a mainly horizontal section of pipe or bore (14) with an inlet (10) for the fluid to be separated and at least two outlets (15, 19) for the separated fluid components, with the length of the pipe being such that the fluid is separated and a boundary layer (25) is formed between the fluid components by the actual conditions of flow, whereby fluid components with a low density are formed in the top part of the pipe and fluid components with a higher density are formed in the bottom part of the pipe.

7. Device according to claim 6,

c h a r a c t e r i s e d i n

that the horizontal section of pipe is an annulus (216) formed between an inner perforated pipe (218) and an outer pipe element (217) which can be an expanded well hole.

8. Device according to claims 6-7,

c h a r a c t e r i s e d i n

that the section of pipe (111, 216) has a flow area which is greater than the flow area at its inlet (110, 212).

9 Device according to claims 6-8,

c h a r a c t e r i s e d i n

that the pipe has inside it one or more coalescence-promoting inserts, preferably in the form of a pierced disc (140) with a downward-pointing cut (141).

10. Device according to claims 6-9,

c h a r a c t e r i s e d i n

that regulation devices (30, 28) are fitted downstream of the outlets for the separated fluid components for regulating the outflow of the individual fluid components from the section of pipe.

11. Device according to claim 10,

c h a r a c t e r i s e d i n

that it comprises means (20) for detecting the level of the boundary layer (25), with the means for detection sending signals to a signal-processing unit which controls the regulation devices (30, 28) for the separated fluid components.

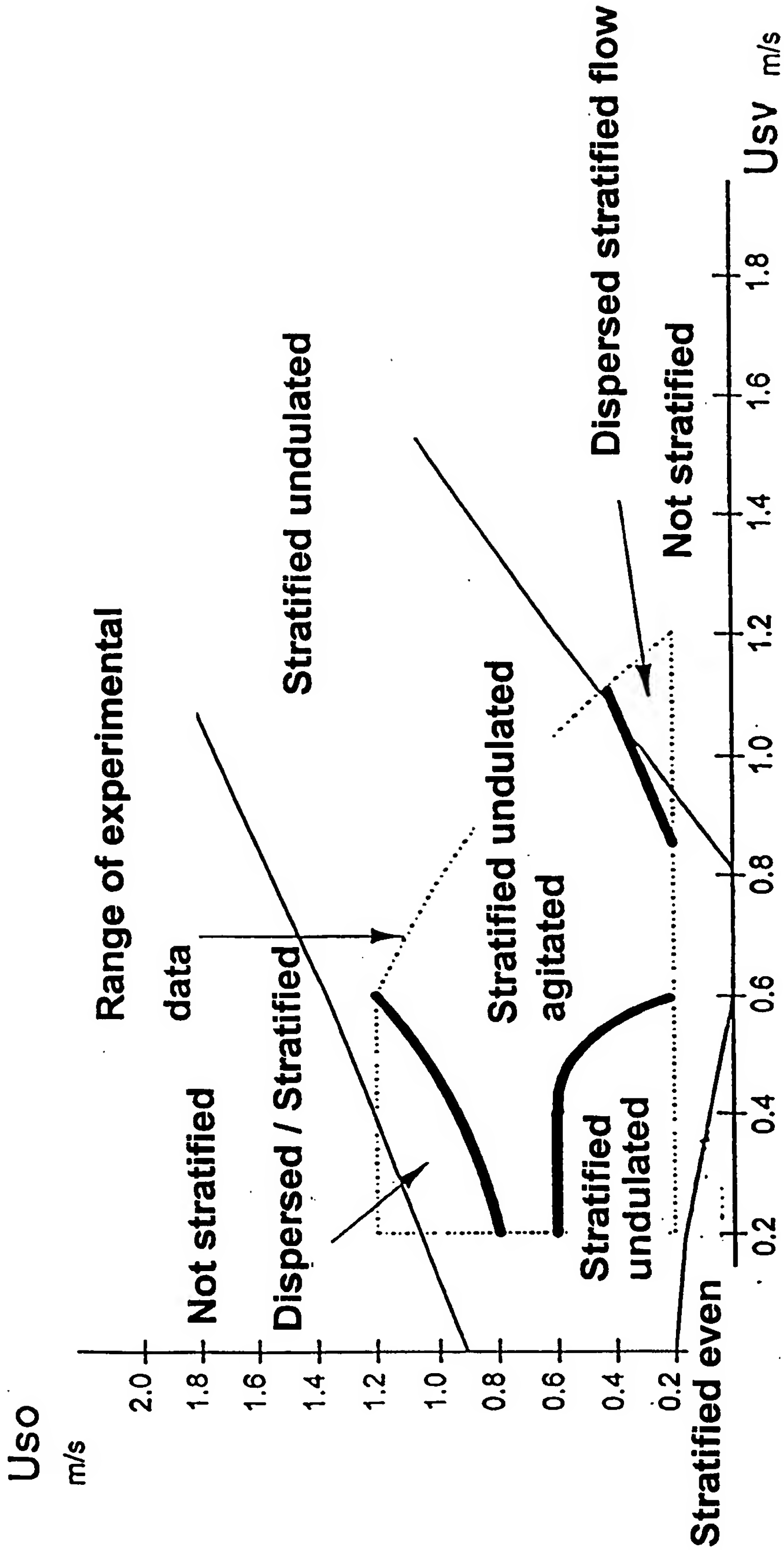
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Fig. 1

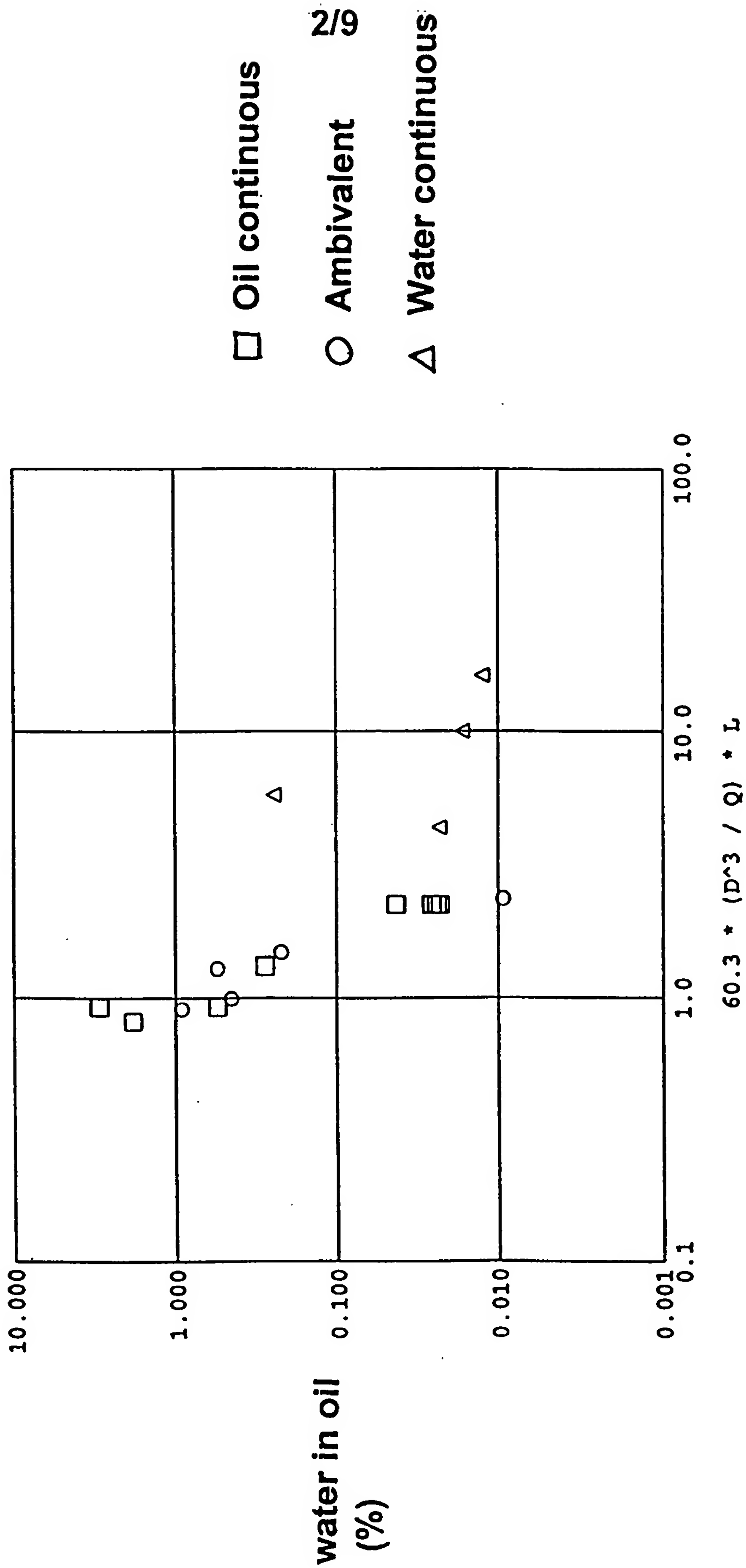
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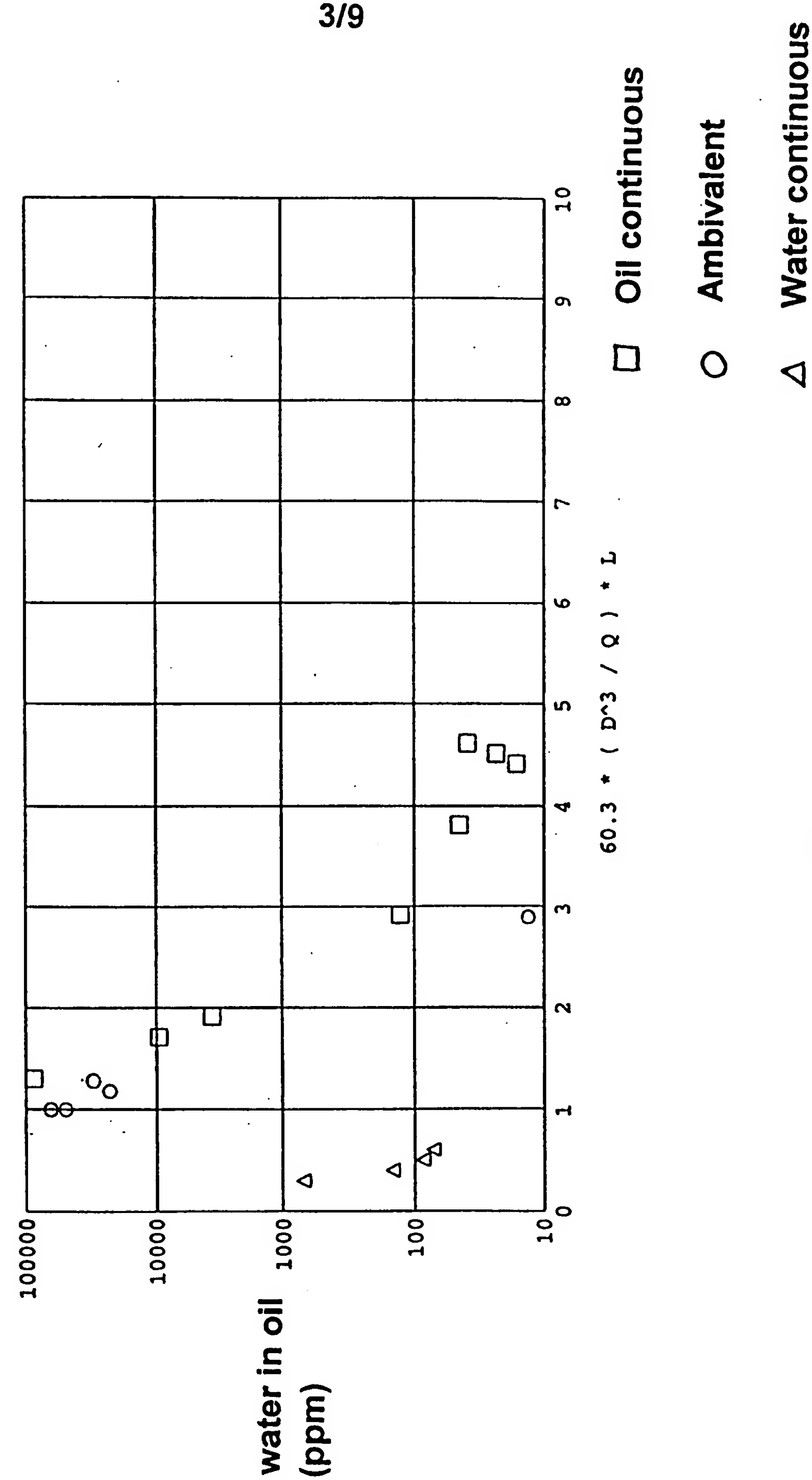
Fig. 2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1
2
3
4
5
6
7
8
9
10
60.3 * (D^3 / Q) * L
Oil continuous
Ambivalent
Water continuous

Fig. 3

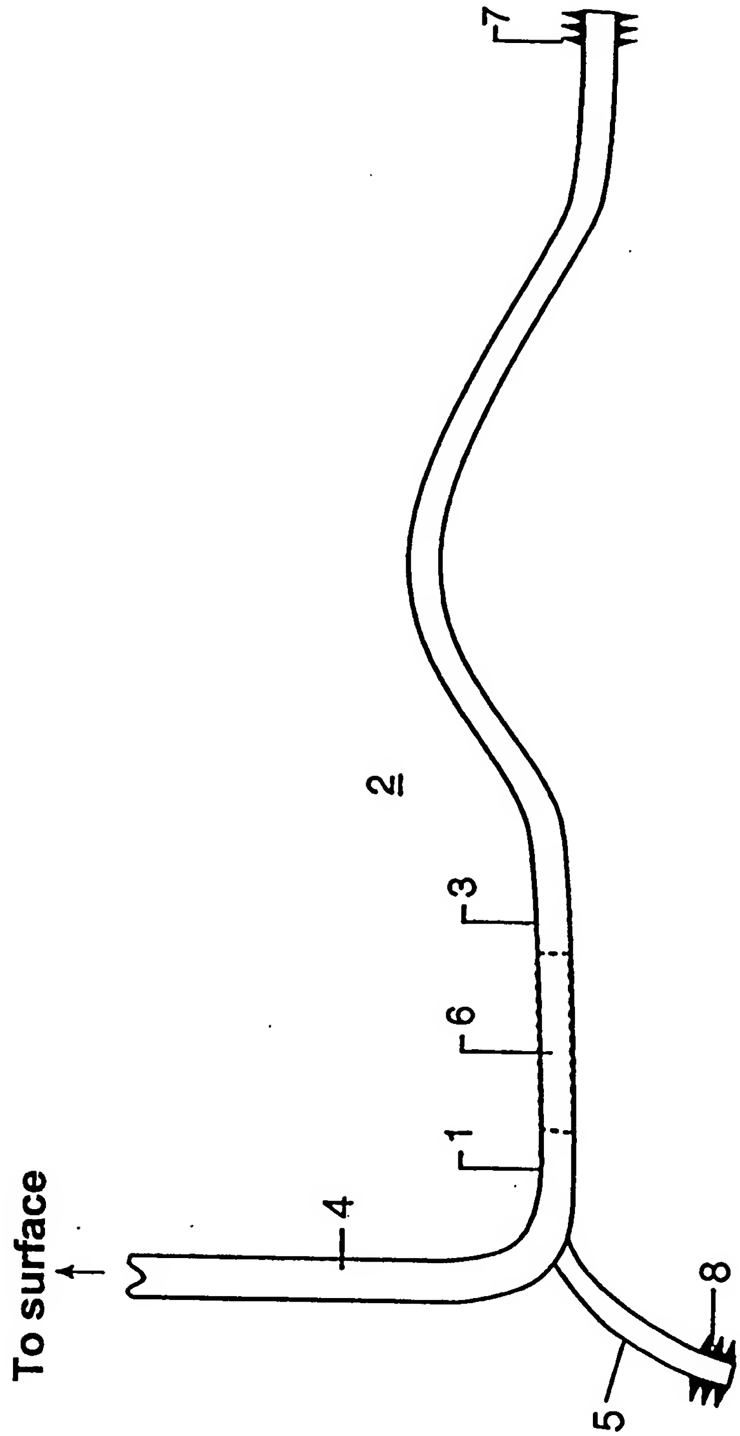


Fig.4

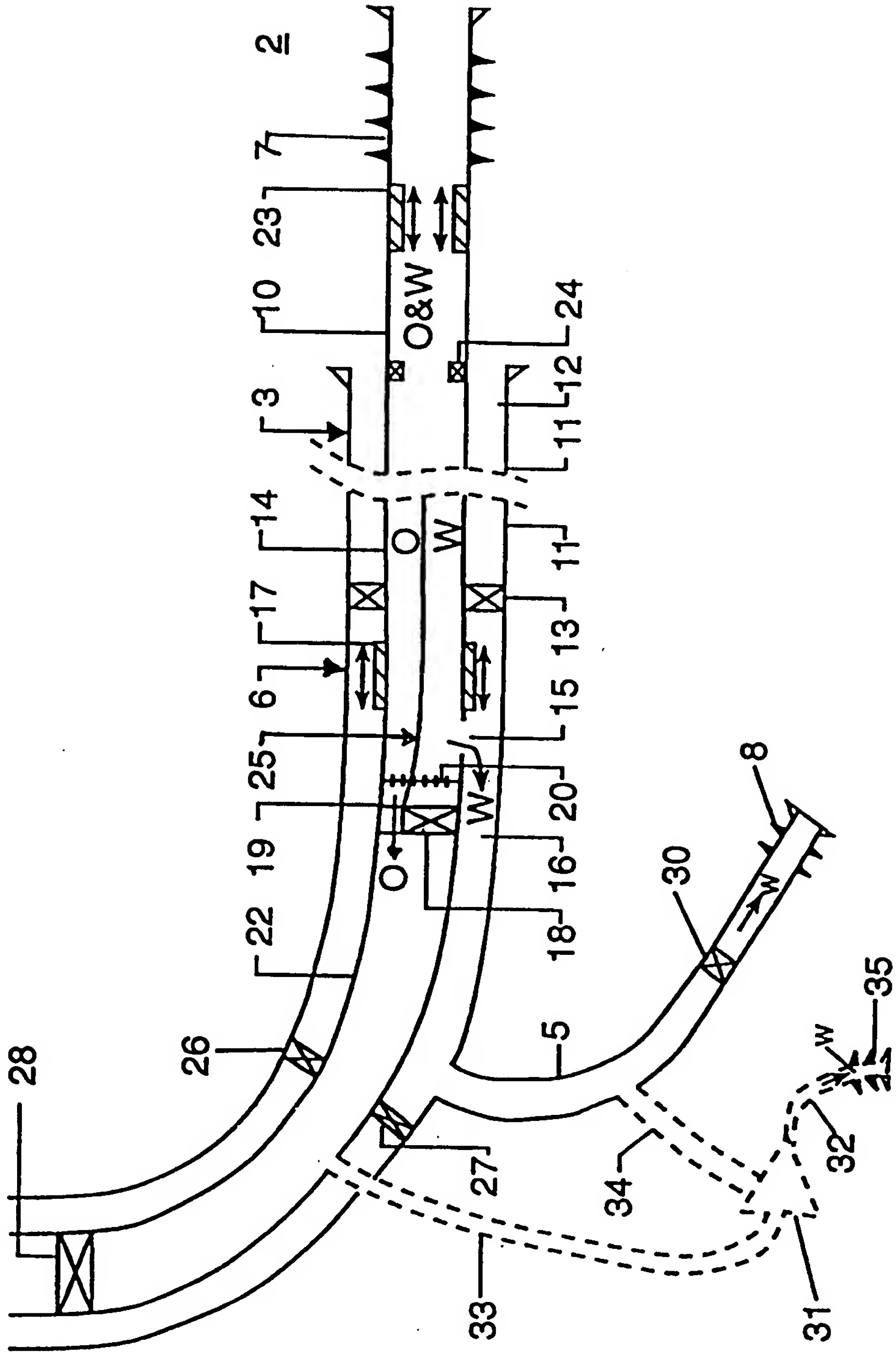
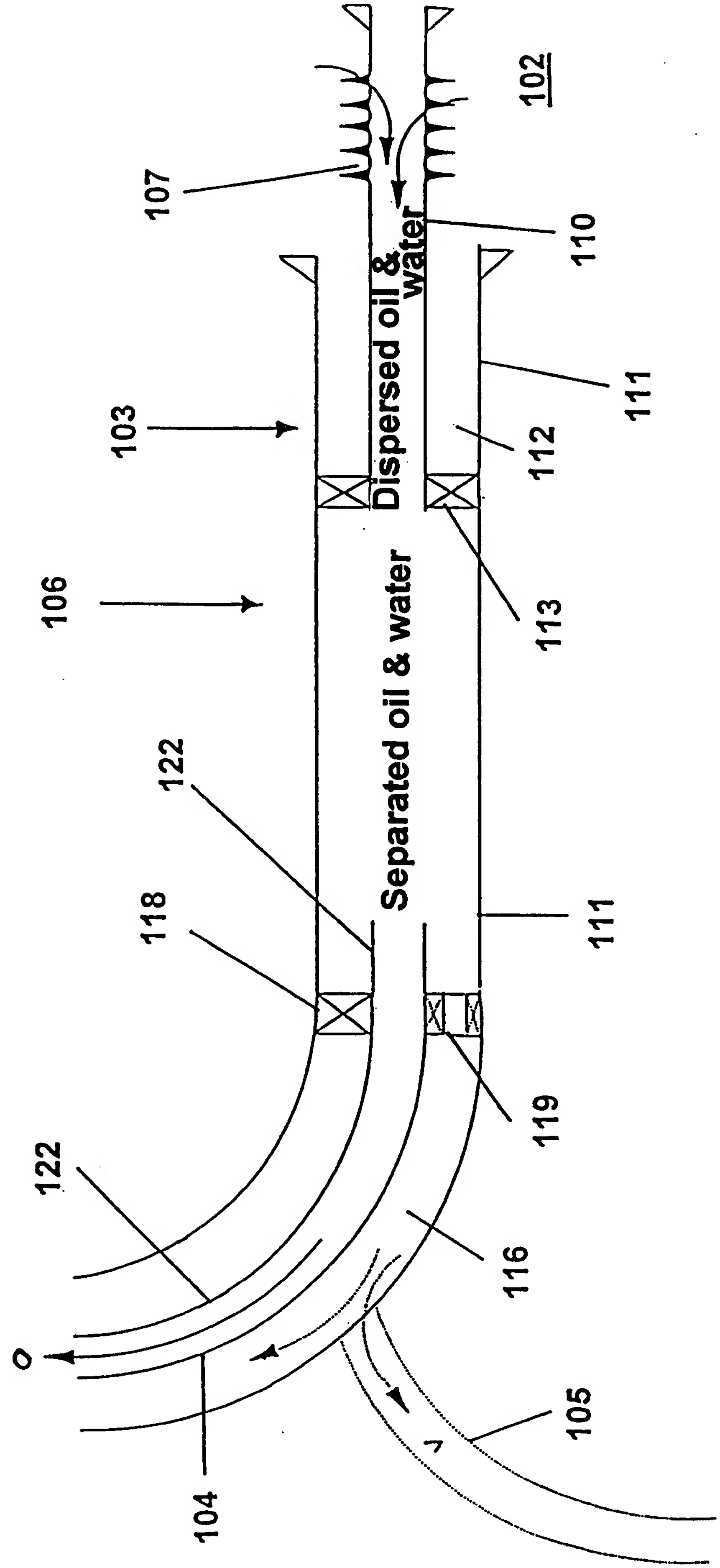

2
7
23
10
O&W
24
3
12
11
14
O
W
11
17
13
6
15
25
20
19
W
O
16
22
18
30
8
W
5
35
W
26
28
27
32
34
33
31

Fig.5



102
107
110
Dispersed oil & water
103
111
112
113
106
Separated oil & water
122
118
111
119
122
116
104
105

Fig. 6

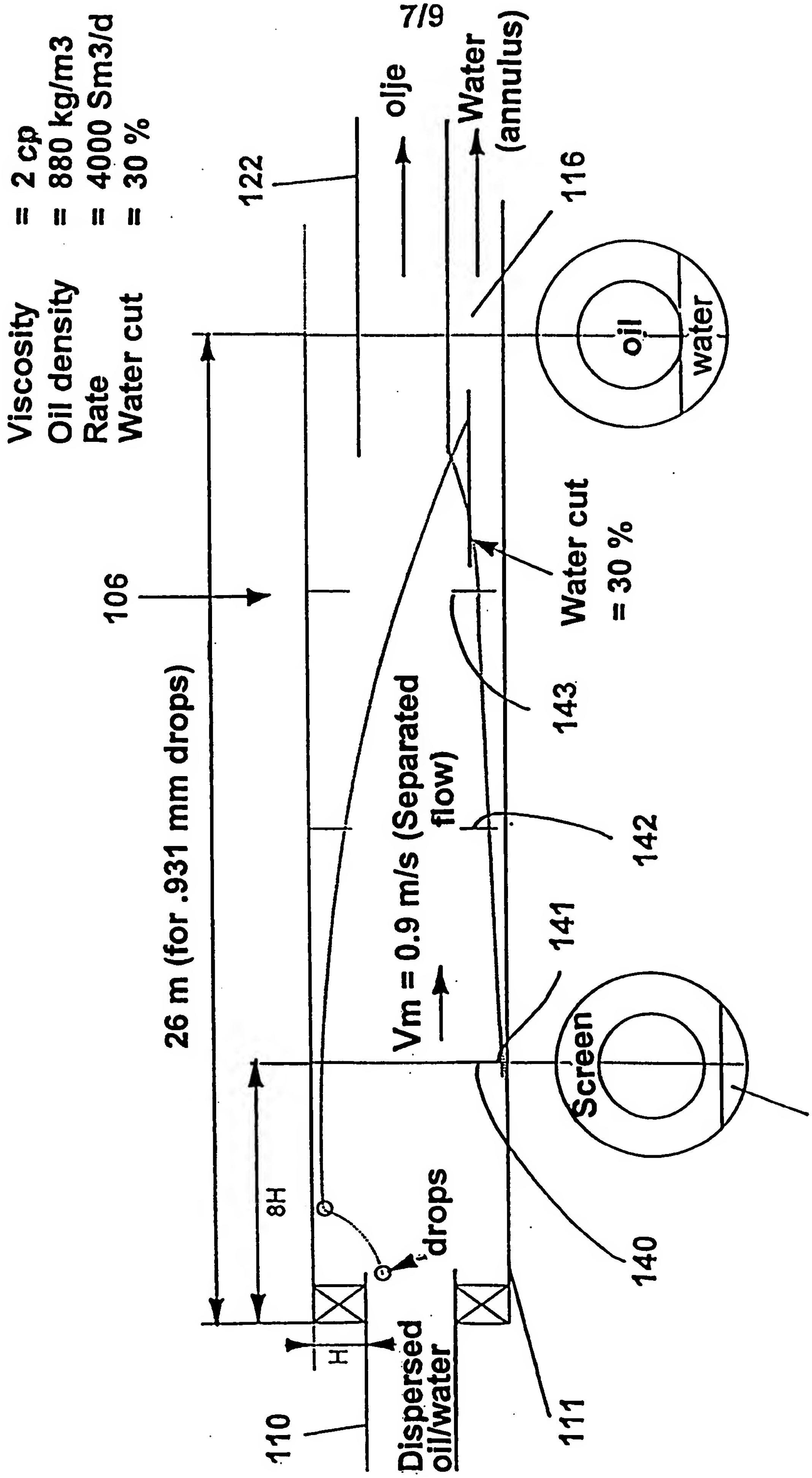
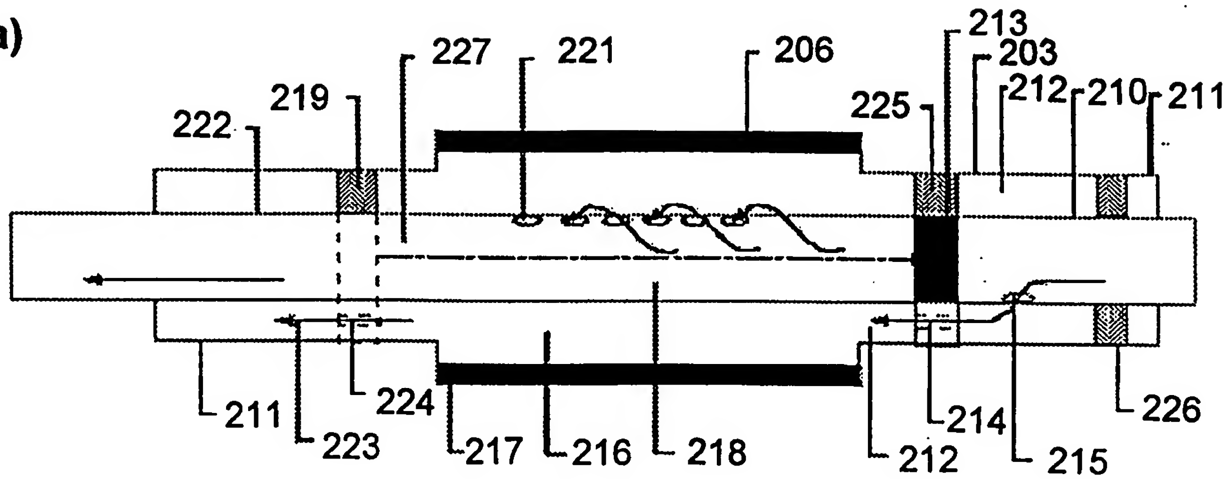

Viscosity = 2 cp
Oil density = 880 kg/m3
Rate = 4000 Sm3/d
Water cut = 30 %
122
olje
Water
(annulus)
116
oil
water
106
26 m (for .931 mm drops)
Water cut
= 30 %
143
Vm = 0.9 m/s (Separated
flow)
142
141
Screen
141
8H
drops
140
H
110
Dispersed
oil/water
111

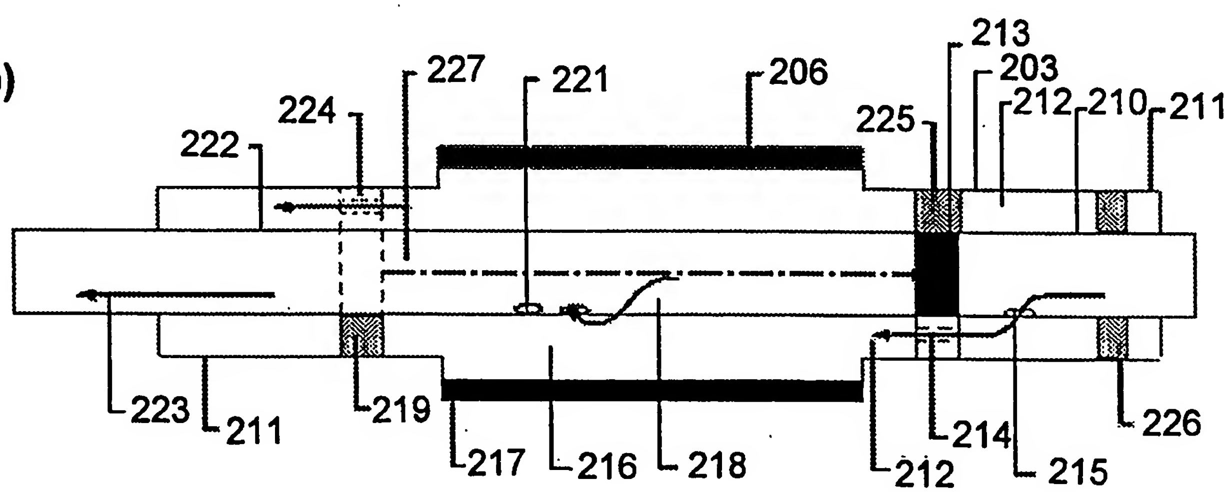
Fig. 7

Fig. 8

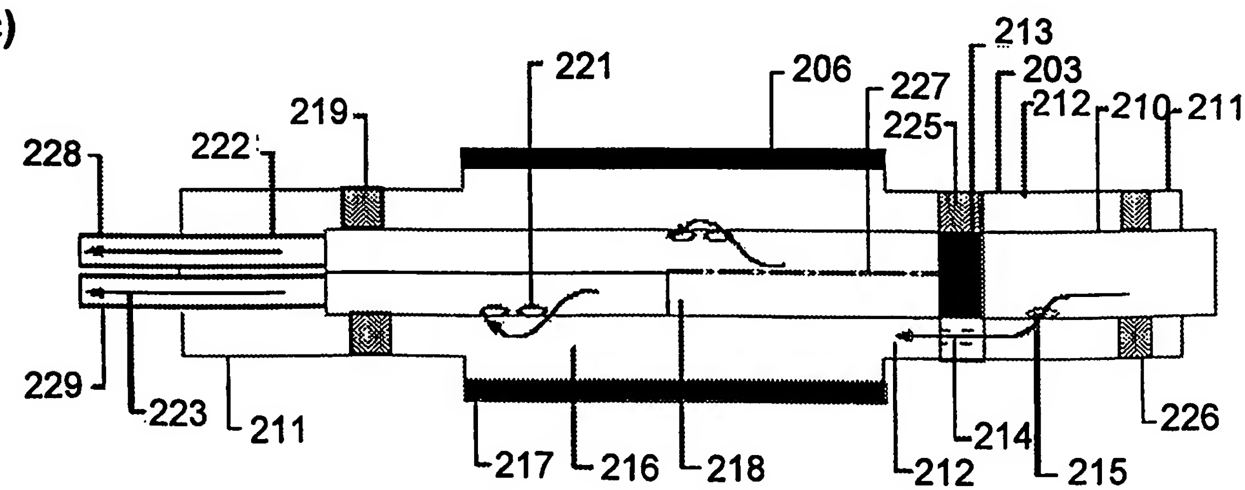
a)


213
203
227
221
206
212
210
211
219
225
222
211
224
223
217
216
218
214
212
215
226

b)


213
227
221
206
203
224
225
212
210
211
222
223
211
219
217
216
218
214
212
215
226

c)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221
206
227
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212
210
211
228
222
229
223
211
217
216
218
214
212
215
226

9/9

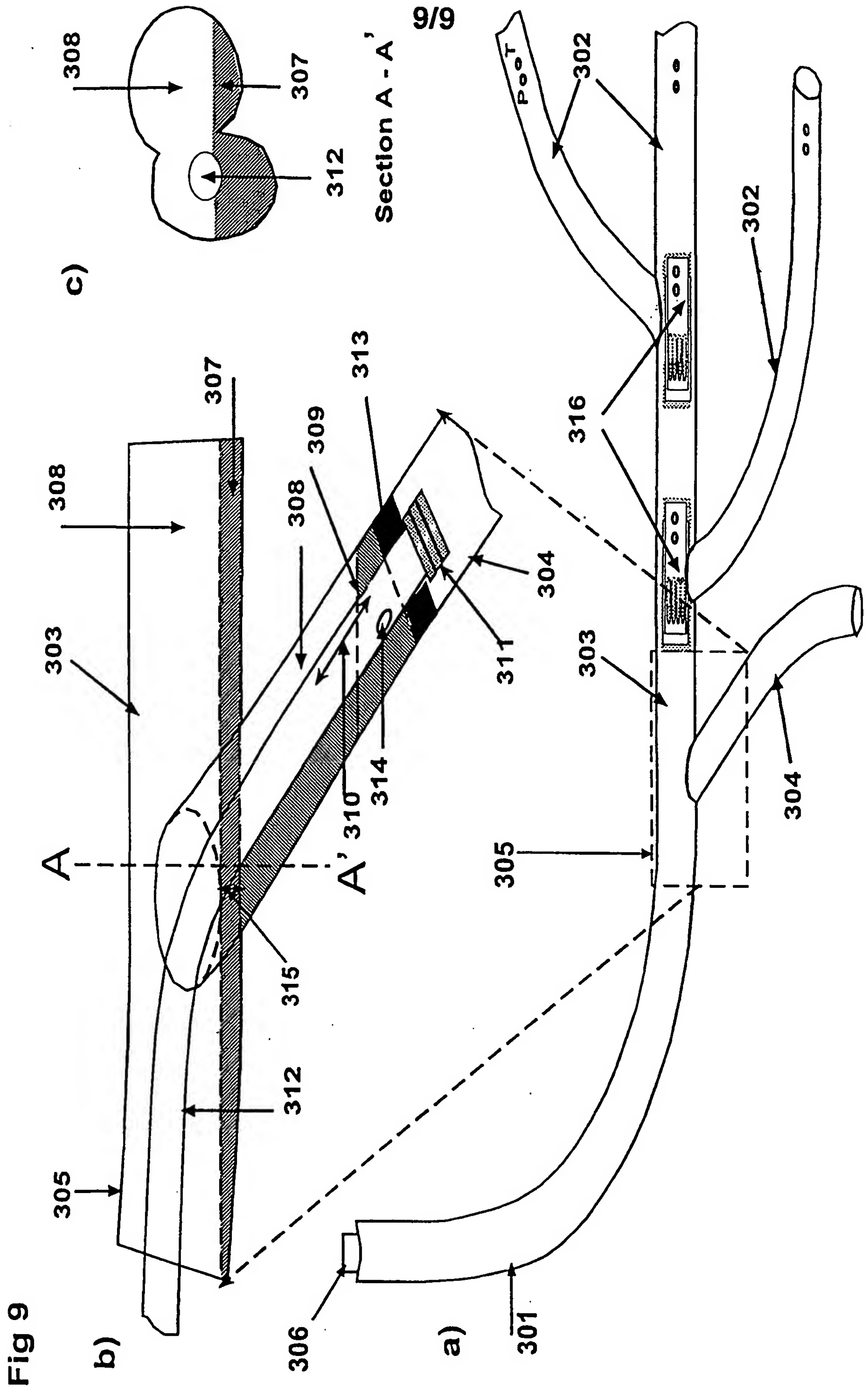
Fig 9
a)
b)
c)
Section A - A'
A
A'
301
302
303
304
305
306
307
308
309
310
311
312
313
314
315
316

INTERNATIONAL SEARCH REPORT

International application No.
PCT/NO 98/00085

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: B01D 17/02, B01D 17/025
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: B01D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPODOC, WPI

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4233154 A (CHARLES L. PRESLEY), 11 November 1980 (11.11.80), figure 1, claims 1-6, abstract --	1,6,8
X	DE 544054 C (DR. EUGEN STEUER), 12 February 1932 (12.02.32), page 2, line 10 - line 56, figure 1, claim 1 --	1,6,8
P,X	NO 962172 B (READ PROCESS ENGINEERING AS), 1 December 1997 (01.12.97), figure 1, abstract --	1,6

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents:
- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" erlier document but published on or after the international filing date
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- "O" document referring to an oral disclosure, use, exhibition or other means
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- "&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
8 June 1998	27 -06- 1998
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Britt-Marie Lundell Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT

International application No.
PCT/NO 98/00085

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0359592 A2 (THE SECRETARY OF STATE FOR THE ENVIRONMENT IN HER BRITANNIC MAJESTY'S GOVERNMENT OF THE UNITED KINGDOM OF GREAT BRITAIN), 21 March 1990 (21.03.90) --	1-11
A	NO 172426 B (CONOCO SPECIALTY PRODUCTS INC.), 13 April 1993 (13.04.93) --	1-11
A	US 4241787 A (ERNEST H. PRICE), 30 December 1980 (30.12.80) -- --------	1-11

INTERNATIONAL SEARCH REPORT
Information on patent family members

29/04/98

International application No.
PCT/NO 98/00085

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 4233154 A	11/11/80	NONE	
DE 544054 C	12/02/32	NONE	
NO 962172 B	01/12/97	NONE	
EP 0359592 A2	21/03/90	NONE	
NO 172426 B	13/04/93	NONE	
US 4241787 A	30/12/80	CA 1134259 A EP 0022357 A,B JP 1267582 C JP 56038102 A JP 59045069 B	26/10/82 14/01/81 10/06/85 13/04/81 02/11/84